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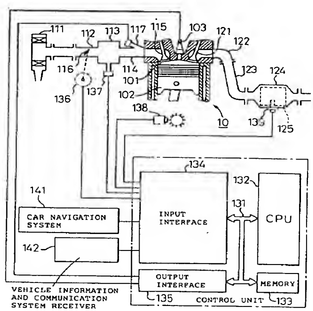
(54) EXHAUST EMISSION CONTROL APPARATUS FOR INTERNAL COMBUSTION ENGINE

(57) In order to perform an optimal operation for regeneration an exhaust gas purifying system (124), the amount of nitrogen oxide (C) absorbed by a catalyst (125, 812) and an exhaust gas temperature (T) are predicted based on the running condition information obtained from a car navigation system (141, 841) or the like after the present time. On the basis of these predictions, a regeneration timing is determined as a time when the amount absorbed by the catalyst (125, 812) is large and the exhaust gas temperature (T) is within a predetermined temperature range. When the predicted regeneration timing occurs, the exhaust gas is enriched so that the nitrogen oxide is released from the catalyst (125, 812) thereby to regenerate the catalyst (125, 812). Note, the nitrogen oxide released from the catalyst (125, 812) is reduced to a harmless substance by hydrocarbons, etc. which remain unburned in the exhaust gas.

When the present invention is applied to a particulate filter (814) of the diesel engine, the frequency of performing the operation of increasing the exhaust gas temperature (T) is reduced, and it is possible to suppress the deterioration of the fuel consumption rate.

Fig.1



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burning off of the particulates by raising the exhaust gas temperature into the predetermined temperature range, by heating with a light oil burner or an electric heater, by closing the intake air, or by combining the above, when it is determined that the exhaust gas temperature is out of the predetermined range based on the rotational speed and the load of the diesel engine.

Nevertheless, when the exhaust gas temperature shifts into the predetermined range and it becomes possible to remove the particulate without heating by the light oil burner or the like after it is determined that the heating with the light oil burner or the like is necessary because the exhaust gas temperature is out of the predetermined range, the fuel consumption rate is unavoidably deteriorated due to the unnecessary heating.

Disclosure of the Invention

Accordingly, the object of the present invention is to provide an exhaust gas purifying system, for an internal combustion engine, which can optimally execute a regeneration operation without deteriorating the fuel consumption rate by predicting a future state of the exhaust gas according to an information fetched from a navigation system or the like.

According to this invention, there is provided an exhaust gas purifying system comprising a trapping means for trapping a poisonous component contained in the exhaust gas emitted from an internal combustion engine, a removing means for removing the poisonous component trapped by said trapping means from the trapping means, an exhaust gas state predicting means for predicting a future state of the exhaust gas emitted from the internal combustion engine, a regeneration timing determining means for determining a regeneration timing to regenerate said trapping means using said removal means based on the state of the exhaust gas predicted by said exhaust gas state predicting means, and a regeneration executing means for executing the regeneration of said trapping means by said removal means at the regeneration timing determined by said regeneration timing determining means.

Brief Description of the Drawings

Figure 1 is a configuration diagram of an embodiment of an exhaust gas purifying system for a gasoline engine according to the present invention.

Figure 2 is a flowchart of a scheduling routine for an exhaust gas purifying system for a gasoline engine.

Figure 3 is a flowchart of a regeneration operation timing determining routine.

Figure 4 is a flowchart of a regeneration operation routine.

Figure 5 is a flowchart of a regeneration execution routine.

Figure 6 is a flowchart of a fuel injection routine.

Figure 7 is a diagram for explaining the effects of the invention.

Figure 8 is a configuration diagram showing an embodiment of an exhaust gas purifying system for a diesel engine according to the invention.

Figure 9 is a diagram showing an operating area for removing particulates.

Figure 10 is a flowchart of a scheduling routine for an exhaust gas purifying system of a diesel engine.

Figure 11 is a flowchart of a second regeneration operation scheduling routine.

Figure 12 is a flowchart of a second regeneration execution routine.

Figure 13 is a diagram for explaining the effects in the case where the exhaust gas purifying system is a particulate filter.

Best Mode for Carrying Out the Invention

Figure 1 is a configuration diagram according to the present invention applied to a gasoline engine.

For the gasoline engine 10, intake air is supplied through an air cleaner 111, an intake pipe 112, a surge tank 113, a branch pipe 114 and an intake valve 115.

A throttle valve 116 is mounted in the intake pipe 112 to control the amount of the intake air supplied to the gasoline engine 10. Also, a fuel injection valve 117 is installed in the branch pipe 114 to inject the fuel into the intake air.

The mixture supplied to a combustion chamber 101 is compressed by the rising of a piston 102 while the piston 102 is moving up, and ignited by a spark plug 103 to be burned near the top dead center so that the piston 102 is moved down to generate driving power.

After burning, the exhaust gas is supplied to an exhaust gas purifying unit 124, through an exhaust valve 121, an exhaust manifold 122 and an exhaust pipe 123, so that it is purified in the purifying unit 124.

The exhaust gas purifying unit 124 contains nitrogen oxide absorbent 125. When the amount of residual oxygen is small in the exhaust gas, the nitrogen oxide is absorbed, while when the amount of residual oxygen in the exhaust gas is large, the nitrogen oxide absorbed is released.

This exhaust gas purifying unit 124 is controlled by a control unit 13 which is a microcomputer system. The control unit 13 consists of not only a bus 131 but also a CPU 132, a memory 133, an input interface 134 and an output interface 135.

To the input interface 134, a throttle opening sensor 137 which detects the opening of the throttle valve 116, an intake air pressure sensor 137 which detects the pressure in the surge tank 113, a crank angle sensor 138 which detects the rotational speed of the gasoline engine 19 and an absorbent temperature sensor 139 which detects the temperature of the absorbent 125 contained in the exhaust gas purifying unit 124 are connected.

Further, at least one of a car navigation system 141

Note, when the determination at step 42 is negative, the control proceeds directly to step 44.

It is determined that whether or not the regeneration execution flag $R(i_i)$ for the running section i_i is "1" at step 44. When the determination at step 44 is negative, that is, when the vehicle is running in the running section for which the regeneration operation is not executed, the control proceeds to step 48 after the air-fuel ratio correction coefficient K is set to a value K_L less than "1.0" (for example, "0.7") in order to execute the lean burning, and the burning state flag XF is set to "0" which indicates that the lean burning is executing.

When the determination at step 44 is affirmative, that is, when the vehicle is running in the section for which the regeneration operation is performed, the control proceeds to step 48 after the regeneration operation is executed at step 47.

It is determined whether or not the vehicle is moving in accordance with the predicted schedule.

This determination can be done by determining whether or not the actual values of the speed, the gasoline engine load (for example, the intake manifold pressure) and the absorbent temperature agree with the corresponding predicted values within the predetermined limits.

When the determination at step 48 is negative, that is, when the vehicle does not run according to schedule, the routine is terminated after the scheduling routine shown in Figure 3 is again executed at step 49. When the determination at step 48 is affirmative, that is, when the vehicle runs according to schedule, this routine is directly terminated.

Figure 5 is a flowchart of a regeneration executing routine executed in step 47. It is determined whether or not the burning state flag XF is "0" at step 471.

When the determination at step 471 is affirmative, that is, when the burning has been under the lean state, the routine is terminated after the air-fuel ratio correction coefficient K is set to a value K_R larger than "1.0" (for example, "1.3") at step 472, and the burning state flag XF is set to "1" which indicates that the rich burning is executing.

When the determination at step 471 is negative, that is, the regeneration operation has already begun, it is determined whether or not the period required for the regeneration operation has elapsed at step 474. When the determination is negative, the control proceeds to step 472, while when the determination is affirmative, the control proceeds to step 475.

That is, when the regeneration operation is regarded as being completed, this routine is terminated after the air-fuel ratio correction coefficient K is set to K_L to restore the burning state to the lean burning at step 475, and the burning state flag XF is set to "0" which indicates that the lean burning is executing at step 476.

Figure 6 is a flowchart of a fuel injection routine for determining the amount of fuel injected from the fuel injection valve 117, that is, the opening time of the fuel injection valve 117, and the rotational speed Ne of the gasoline engine and the intake pipe pressure PM are fetched at step 61.

The basic fuel injecting period TP is calculated as a function of the rotational speed Ne of the gasoline engine and the intake manifold pressure PM.

$$TP \leftarrow TP(Ne, PM)$$

Note, the basic fuel injecting period TP is determined as the opening period of the fuel injection valve for supplying the amount of fuel required for burning at the stoichiometric air-fuel ratio.

At step 63, the basic fuel injecting period TP is multiplied by the air-fuel ratio correction coefficient K to calculate the fuel injecting period TAU.

$$TAU \leftarrow K \cdot TP$$

Consequently, as long as the air-fuel ratio correction coefficient K is set to K_L, the gasoline engine is in a lean burning state, while as long as it is set to K_R, the gasoline engine is in a rich burning state.

Figure 7 is a diagram for explaining the effects of the present invention when it is applied to the gasoline engine. The abscissa denotes the time.

(a) shows the information of the route and the traffic congestion forecast obtained from the car navigation system 141 and the vehicle information and communication system receiver 142 and the vehicle speed predicted based on the above information.

(b) shows the load of the gasoline engine, the absorbent temperature and the concentration of nitrogen oxide predicted by the control unit 13.

(c) shows the amount of the nitrogen oxide absorbed in the absorbent and the amount of the nitrogen oxide released from the absorbent predicted by the control unit 13.

Namely, the regeneration operation is postponed in the exhaust gas purifying system until the absorbent temperature moves into the temperature range where nitrogen oxide can never be emitted as long as the absorbent retains its absorbing power while the absorbent temperature is in the temperature range where nitrogen oxide may be emitted when it is determined that the amount of nitrogen oxide absorbed in the absorbent becomes a maximum.

(d) shows the regeneration operation performed by the conventional exhaust gas purifying system of the gasoline engine. Namely, when it is determined that the amount of the nitrogen oxide absorbed in the absorbent becomes a maximum, the regeneration operation is carried out regardless of the absorbent temperature. When the absorbent temperature is high, therefore, nitrogen oxide is una-

or the closing of the throttle valve 84.

Therefore, it is necessary to make a schedule to perform the regeneration of the particulate filter 814 in the operating zones "3" or "5".

Figure 10 is a flowchart of a second scheduling routine executed by the control unit 13 before the vehicle begins running, and the information of the route searched by the car-navigation system 841, such as traveling distance, road type (whether express road or normal road), altitude, etc., is fetched at step 101.

The traffic congestion forecast, traffic control information, etc. received by the vehicle information and communication system receiver 842 at step 102.

At step 103, the route to the destination are divided into i_{max} sections according to the information and the traffic congestion forecast, and then a traveling distance D(i), a running speed S(i), a load of the diesel engine L(i), an amount of generated particulate C(i), a temperature of the exhaust gas Tg(i), etc. are predicted for each section i ($1 \leqq i \leqq i_{max}$).

At step 104, in order to determine the regeneration timing of the exhaust gas purifying system for all sections, a section index i_s is set to "1" as the initial value, and the regeneration scheduling routine for the particulate filter is executed at step 105 to terminate the routine.

Figure 11 is a flowchart of a particulate filter regeneration scheduling routine executed at step 105. At step 105a, the amount of particulate $C(i_s)$ generated while the vehicle is running in the current section "i_s" is added to the amount of particulate S trapped by the particulate filter 814 after the vehicle has completed running at the previous section to determine the amount of particulate S trapped when the vehicle has completed running at the section "i_s", and the operating zone of the section "i_s" is determined at step 105b.

When it is determined that the operating zone of the running section "i_s" is "1" or "2" at step 105b, the control proceeds to step 105c where it is determined whether or not the trapped amount of particulate S is larger than the maximum amount S_{max} (for example, 120 %).

When the determination at step 105c is negative, that is, when the particulate filter 814 has a margin of trapping power, the regeneration operation flag $R(i_s)$ for the section "i_s" is set to "0" which indicates that any regeneration operations such as burning of the light oil, heating with the electric heater or closing of the throttle valve are not performed.

When the determination at step 105c is affirmative, that is, when the particulate filter 814 has no margin of trapping power, it is determinated whether or not the operating zone corresponding to the section "i_s" is "1" or "2". If the operating zone is "1", the regeneration operation flag $R(i_s)$ is set to "3" which indicates that the heating by burning of light oil and the heating by the electric heater are used at the same time at step 105f. When the operating zone is "2", on the other hand, the regeneration operation flag $R(i_s)$ is set to "2" which indicates that the heating by the electric heater and closing of the throttle valve are used at the same time.

When the determination at step 105b is that the operating zone for the section "i_s" is "3" or "5", the control proceeds to step 105h where the regeneration operation flag $R(i_s)$ for section "i_s" is set to "0" because the particulates can be removed without a regeneration operation.

When the determination at step 105b is that the operating zone for the section is "4", the control proceeds to step 105i where it is determined whether or not the trapped amount of particulate S is larger than a middle amount S_{mid} (for example, 100 %).

When the determination at step 105i is affirmative, that is, when the trapped amount of particulate S is not less than the middle amount S_{mid}, the regeneration operation of the particulate filter 814 is possible without deteriorating the fuel consumption rate in the operating zone "4". In order to perform the regeneration operation beforehand, the regeneration operation flag $R(i_s)$ is set to "1" which indicates that the throttle valve is slightly throttled.

When the determination at step 105i is negative, that is, when the trapped amount of particulate S is less than the middle amount S_{mid}, the regeneration operation flag $R(i_s)$ for the section "i_s" is set to "0" which indicates that the regeneration operation is not performed because the particulate filter 814 has a margin of trapping power.

After completing the processing at steps 105f, 105g, 105h and 105i, the control proceeds to step 105m after the amount of trapped particulates S is reset at step 1051.

After completing the processing at steps 105d and 105k, the control proceeds directly to step 105m without resetting the amount of trapped particulate S because the regeneration operation of the particulate filter is not performed.

It is determined whether or not the prediction for all sections at step 105m, that is, whether or not the section index "i_s" has reached the maximum value i_{max}.

When the determination at step 105m is negative, the control returns to step 105a after the section index "i_s" is incremented at step 105n. When the determination at step 105m is affirmative, in contrast, this routine is directly terminated.

Figure 12 is a flowchart of a second regeneration operation routine executed after the vehicle begins running. This routine is executed as an interrupt routine every predetermined interval.

The actual traveling distance after the vehicle begins running is read out, for example, from the trip meter at step 120, and it is determined that the actual traveling distance is larger than the predicted traveling distance $D_s(i_t)$ up to the section i_t. The section i_t and the predicted distance D_s are assumed to be set to "0" in the initialization routine which not shown.

When the determination at step 121 is affirmative,

a regeneration executing means for executing the regeneration of said trapping means by said removing means when the timing determined by said regeneration timing determining means occurs.

2. An exhaust gas purifying system for a gasoline engine comprising:

a catalyst for trapping nitrogen oxide in the exhaust gas emitted from said gasoline engine when the exhaust gas is in lean state;
an enriching means for enriching the exhaust gas for regeneration said catalyst by releasing nitrogen oxide trapped in said catalyst;
a running condition predicting means for predicting the running condition of the vehicle after the present time;
an exhaust gas temperature predicting means for predicting the temperature of exhaust gas emitted from the internal combustion engine based on the vehicle running condition predicted by said running condition predicting means;
an enriching timing determining means for determining the timing of regeneration said catalyst by said enriching means based on the exhaust gas temperature predicted by said exhaust gas temperature predicting means; and
a regeneration executing means for regeneration said catalyst by enriching the exhaust gas by said enriching means when the enriching timing determined by said enriching timing determining means occurs.

3. An exhaust gas purifying system for a gasoline engine according to claim 2,
wherein said enriching timing determining means determines the time point when the exhaust gas temperature predicted by said exhaust gas temperature predicting means is lower than a predetermined regeneration temperature as the catalyst regeneration timing.

4. An exhaust gas purifying system for a gasoline engine according to claim 2, further comprising:

an agreement judging means for judging whether or not the running condition predicted by said running condition predicting means agrees with the actual running condition and whether or not the exhaust gas temperature predicted by said exhaust gas temperature predicting means agrees with the actual exhaust gas temperature; and
a re-predicting means for re-predicting the vehicle running condition after the present time by said running condition predicting means and re-predicting the temperature of the exhaust gas emitted from the gasoline engine based on said re-predicted vehicle running condition when said agreement judging means does not judge agreement.

5. An exhaust gas purifying system for a diesel engine, comprising:

a particulate filter for trapping particulate emitted from said diesel engine;
an exhaust gas temperature raising means for raising the exhaust gas temperature for regeneration said particulate filter by burning off particulate trapped in said particulate filter;
a running condition prediction means for predicting the vehicle running condition after the present time;
an exhaust gas temperature predicting means for predicting the temperature of exhaust gas emitted from said diesel engine based on the vehicle running condition predicted by said running condition predicting means;
an exhaust gas temperature raising timing determining means for determining the regeneration timing of said particulate filter by said exhaust gas temperature raising means based on the exhaust gas temperature predicted by said exhaust gas temperature predicting means; and
a regeneration executing means for executing the regeneration of said particulate filter by raising the exhaust gas temperature by said exhaust gas temperature raising means when the exhaust gas temperature raising timing determined by said exhaust gas temperature raising timing determining means occurs.

6. An exhaust gas purifying system for a diesel engine according to claim 5,
wherein said exhaust gas temperature raising means is at least one of a means for slightly closing the throttle valve, an electric heater for heating the exhaust gas with the electrically-generated heat, and a fuel supply means for burning the fuel in the exhaust gas to heat the exhaust gas.

7. An exhaust gas purifying system for a diesel engine according to claim 5,
wherein said particulate filter contains a catalyst for naturally burning off particulates; and
said regeneration executing means executes the regeneration of said particulate filter by natural burning without activating said exhaust gas temperature raising means when the exhaust gas temperature is higher than about 600°C.

Fig.1

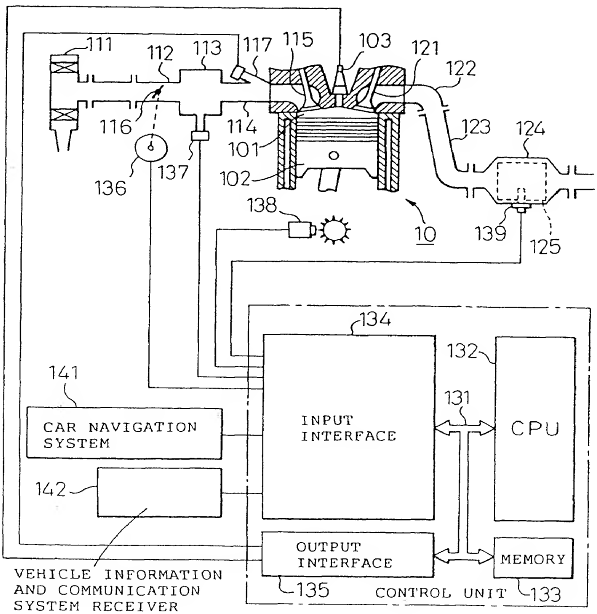

111
112
113
117
115
103
121
122
116
114
101
136
137
102
123
124
138
10
139
125
134
132
131
141
CAR NAVIGATION SYSTEM
INPUT INTERFACE
CPU
142
OUTPUT INTERFACE
MEMORY
VEHICLE INFORMATION AND COMMUNICATION SYSTEM RECEIVER
135
CONTROL UNIT
133

Fig.2

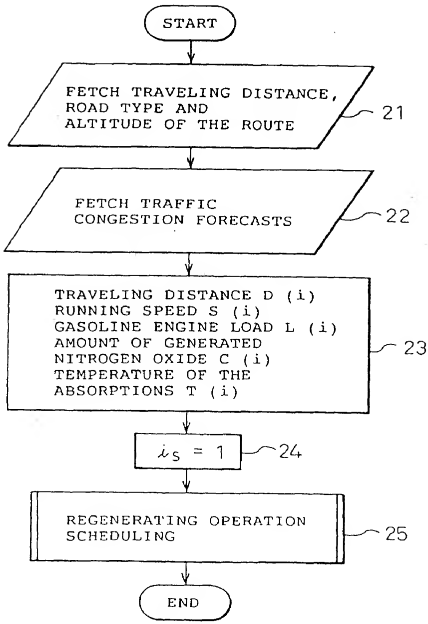

START
FETCH TRAVELING DISTANCE, ROAD TYPE AND ALTITUDE OF THE ROUTE
21
FETCH TRAFFIC CONGESTION FORECASTS
22
TRAVELING DISTANCE D (i)
RUNNING SPEED S (i)
GASOLINE ENGINE LOAD L (i)
AMOUNT OF GENERATED NITROGEN OXIDE C (i)
TEMPERATURE OF THE ABSORPTIONS T (i)
23
i_S = 1
24
REGENERATING OPERATION SCHEDULING
25
END

Fig.3

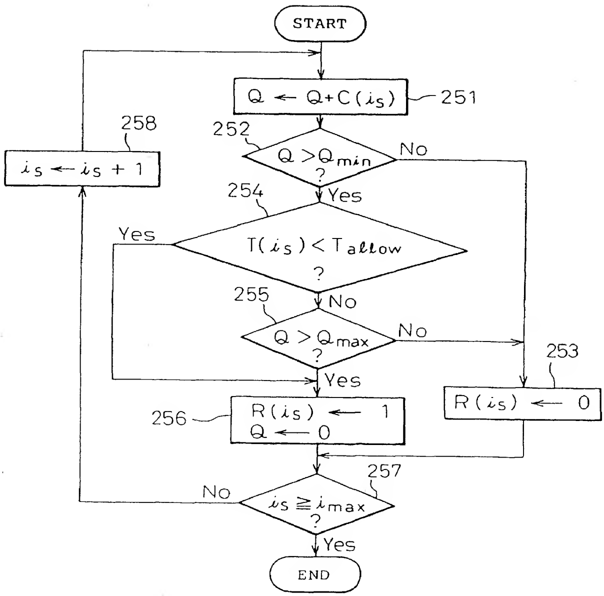

START
Q ← Q+C(is)
251
252
Q > Qmin ?
No
Yes
258
is ← is + 1
254
T(is) < Tallow ?
Yes
No
255
Q > Qmax ?
No
Yes
253
R(is) ← 0
256
R(is) ← 1
Q ← 0
257
is ≧ imax ?
No
Yes
END

Fig.4

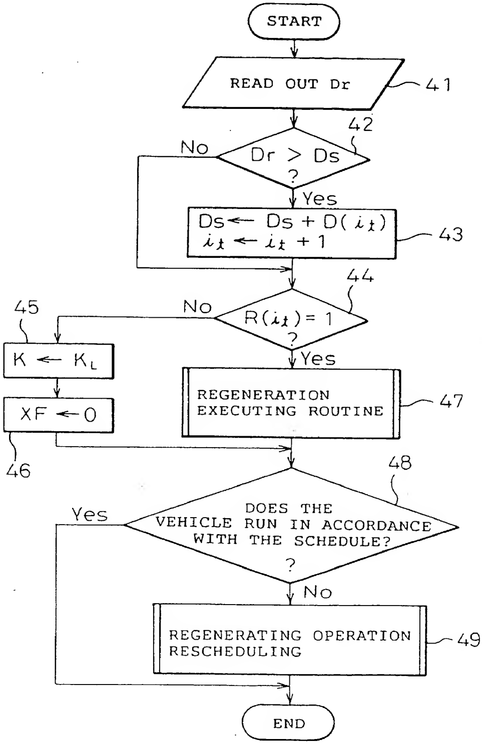

START
READ OUT Dr
41
42
Dr > Ds ?
No
Yes
Ds ← Ds + D(i_t)
i_t ← i_t + 1
43
44
R(i_t) = 1 ?
No
Yes
45
K ← K_L
XF ← 0
46
REGENERATION EXECUTING ROUTINE
47
48
DOES THE VEHICLE RUN IN ACCORDANCE WITH THE SCHEDULE? ?
Yes
No
REGENERATING OPERATION RESCHEDULING
49
END

Fig.5

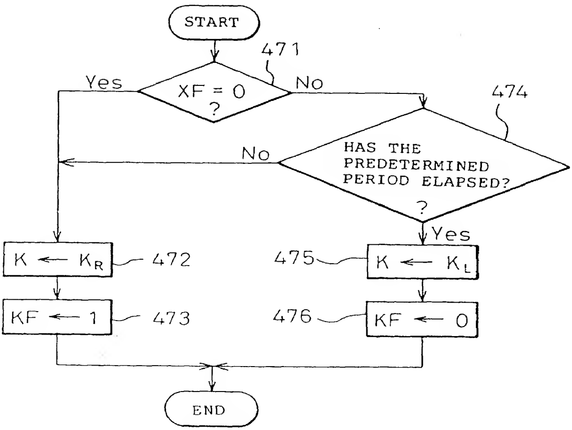

START
471
XF = 0 ?
Yes
No
474
HAS THE PREDETERMINED PERIOD ELAPSED ?
No
Yes
K ← K_R
472
KF ← 1
473
475
K ← K_L
476
KF ← 0
END

Fig.6

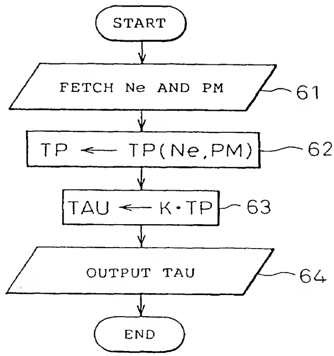

START
FETCH Ne AND PM
61
TP ← TP(Ne,PM)
62
TAU ← K·TP
63
OUTPUT TAU
64
END

Fig.7

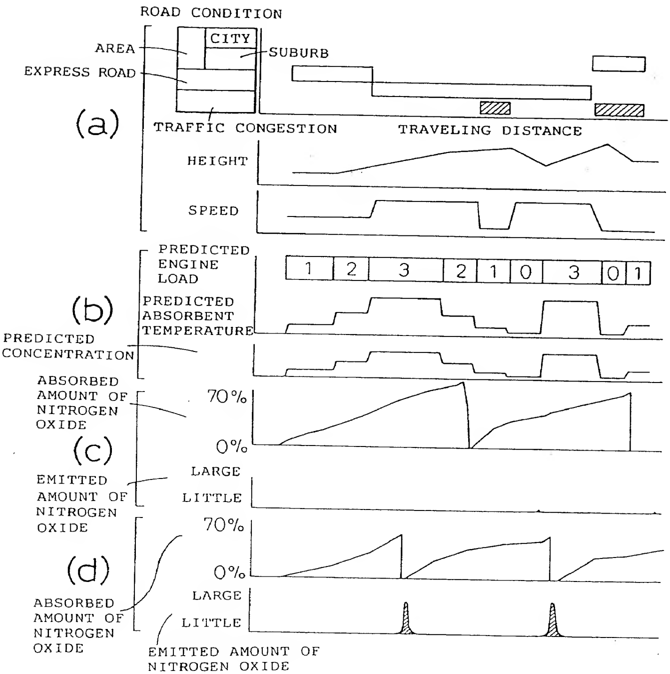

ROAD CONDITION
AREA
CITY
SUBURB
EXPRESS ROAD
(a)
TRAFFIC CONGESTION
TRAVELING DISTANCE
HEIGHT
SPEED
PREDICTED ENGINE LOAD
1 2 3 2 1 0 3 0 1
(b)
PREDICTED ABSORBENT TEMPERATURE
PREDICTED CONCENTRATION
ABSORBED AMOUNT OF NITROGEN OXIDE
70%
0%
(c)
LARGE
LITTLE
EMITTED AMOUNT OF NITROGEN OXIDE
70%
0%
(d)
LARGE
LITTLE
ABSORBED AMOUNT OF NITROGEN OXIDE
EMITTED AMOUNT OF NITROGEN OXIDE

Fig.8

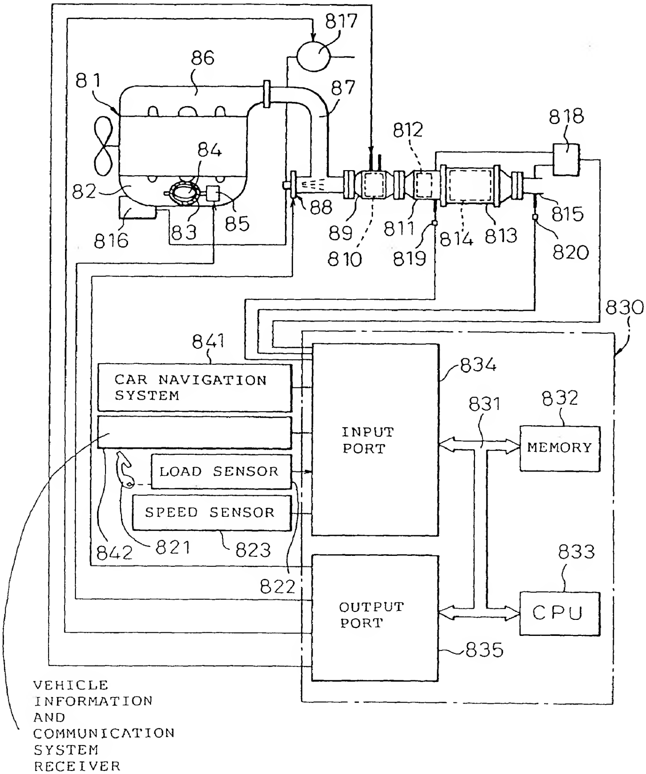

817
86
81
87
812
818
84
82
88
815
89
811
814
813
816
83
85
820
810
819
830
841
CAR NAVIGATION SYSTEM
834
831
832
INPUT PORT
MEMORY
LOAD SENSOR
SPEED SENSOR
842
821
823
833
822
OUTPUT PORT
CPU
835
VEHICLE INFORMATION AND COMMUNICATION SYSTEM RECEIVER

Fig.9

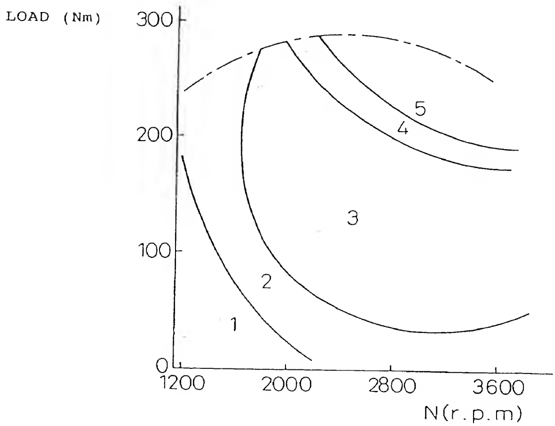


Fig.10

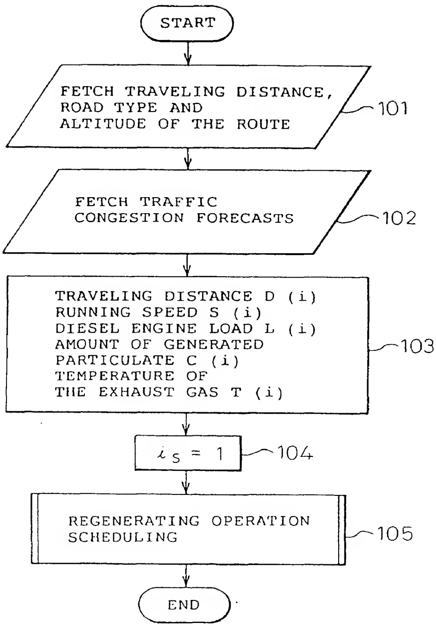

START
FETCH TRAVELING DISTANCE, ROAD TYPE AND ALTITUDE OF THE ROUTE
101
FETCH TRAFFIC CONGESTION FORECASTS
102
TRAVELING DISTANCE D (i)
RUNNING SPEED S (i)
DIESEL ENGINE LOAD L (i)
AMOUNT OF GENERATED PARTICULATE C (i)
TEMPERATURE OF THE EXHAUST GAS T (i)
103
$i_s = 1$
104
REGENERATING OPERATION SCHEDULING
105
END

Fig.11

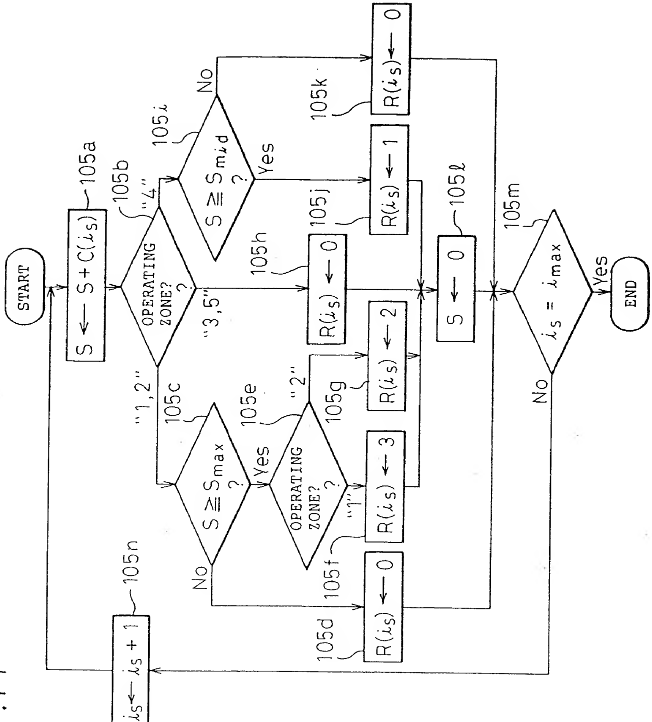
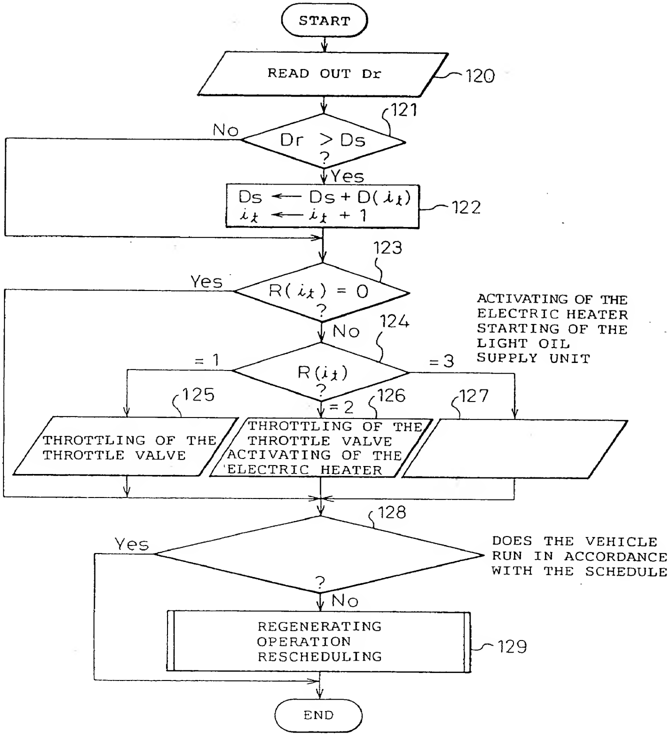
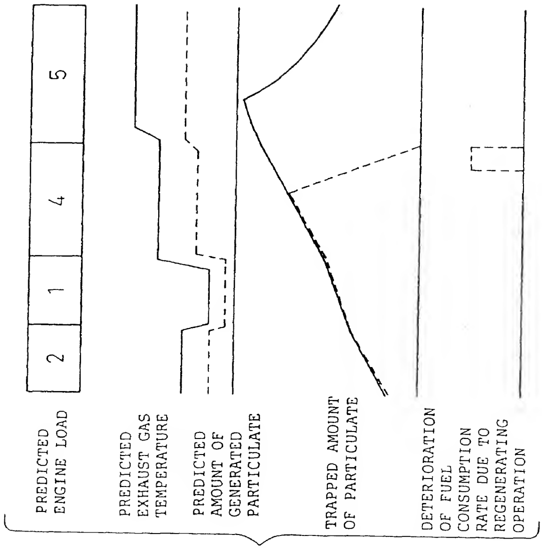

START
S ← S + C(i_s)
105a
105b
OPERATING ZONE?
"4"
"3,5"
"1,2"
105i
S ≧ S_mid ?
Yes
No
R(i_s) ← 0
105k
R(i_s) ← 1
105j
105h
R(i_s) ← 0
S ← 0
105ℓ
105m
i_s = i_max
Yes
END
No
105c
S ≧ S_max ?
Yes
No
105e
"2"
OPERATING ZONE?
"1"
105g
R(i_s) ← 2
R(i_s) ← 3
105f
R(i_s) ← 0
105d
105n
i_s ← i_s + 1

Fig.12


START
READ OUT Dr
120
121
No
Dr > Ds ?
Yes
Ds ← Ds + D(i_t)
i_t ← i_t + 1
122
123
Yes
R(i_t) = 0 ?
No
124
= 1
R(i_t) ?
= 3
= 2
ACTIVATING OF THE ELECTRIC HEATER STARTING OF THE LIGHT OIL SUPPLY UNIT
125
THROTTLING OF THE THROTTLE VALVE
126
THROTTLING OF THE THROTTLE VALVE ACTIVATING OF THE ELECTRIC HEATER
127
128
Yes
DOES THE VEHICLE RUN IN ACCORDANCE WITH THE SCHEDULE ?
No
REGENERATING OPERATION RESCHEDULING
129
END



2
1
4
5
PREDICTED ENGINE LOAD
PREDICTED EXHAUST GAS TEMPERATURE
PREDICTED AMOUNT OF GENERATED PARTICULATE
TRAPPED AMOUNT OF PARTICULATE
DETERIORATION OF FUEL CONSUMPTION RATE DUE TO REGENERATING OPERATION

Fig. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP96/03184

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl[6] F01N3/20, F01N3/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl[6] F01N3/20, F01N3/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1926 - 1996
Kokai Jitsuyo Shinan Koho 1971 - 1996

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 5-59929, A (Nissan Motor Co., Ltd.), March 9, 1993 (09. 03. 93)(Family: none)	1 - 9
A	JP, 6-50130, A (Toyota Motor Corp.), February 22, 1994 (22. 02. 94)(Family: none)	1 - 9
A	JP, 7-34854, A (Nissan Motor Co., Ltd.), February 3, 1995 (03. 02. 95)(Family: none)	1 - 9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
January 22, 1997 (22. 01. 97)	February 4, 1997 (04. 02. 97)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)